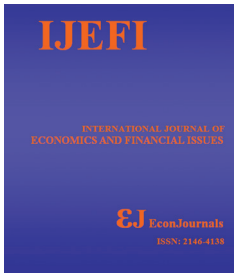


International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2019, 9(4), 11-17.

Labour Productivity Growth and Convergence in Agriculture of the European Union

Zbigniew Gołaś*

Department of Economics and Social Sciences, Poznań University of Life Sciences, Poland. *Email: zbigniew.golas@up.poznan.pl

Received: 15 March 2019 **Accepted:** 10 June 2019 **DOI:** https://doi.org/10.32479/ijefi.8041

ABSTRACT

The main objective of the presented paper is to examine and assess the changes in labour productivity (LP) in the EU agriculture in the context of the diversity of its level and dynamics of change underlying the identification of LP convergence/divergence processes taking place in agriculture. The LP convergence processes in the EU agriculture were analysed based on data from the period between 2005 and 2016, by testing two its basic types, namely sigma and beta convergence. The analysis applied statistical measures describing the degree of LP differentiation in agriculture of the EU countries and cross-sectional regression function. The research showed that sigma and beta convergence exist in general in the EU-28 countries.

Keywords: Labour Productivity, Convergence, Agriculture, EU
JEL Classifications: Q13, O47, C2

1. INTRODUCTION

In the aspect of integration processes taking place in the EU, a particular importance should be placed on the issue of labour productivity (LP), conditioned by two basic factors. First of all, its low level in many of the EU countries is the main barrier to the transition to an intensive growth path. Secondly, changes in LP will largely determine both the dynamics and costs of integration on the European and global scale, and the degree of levelling significant differences in the level of socio-economic development of the EU countries. It should also be emphasised that the level of LP is widely recognised as one of the most important development parameters of economies because it leads to lower costs, increased supply of cheaper goods and services, it makes the market more dynamic and increases the purchasing power of societies, their wealth and competitive capacity. The above-comments refer to the entire economy, but especially to the agricultural sector, where the level of LP in the EU countries is strongly differentiated and significantly lower than in other sectors of the economy.

Therefore, the main goal of the presented article is to examine and assess the changes in LP across the EU agricultural sector at the backdrop of diversification of its level and dynamics of change, forming the grounds for identifying the processes of convergence/divergence of LP taking place in agriculture.

2. SOURCE MATERIALS AND RESEARCH METHODOLOGY

The study uses the Economic Accounts for Agriculture, i.e., harmonised financial reports effective in the EU which enable analysis of the economic situation in agriculture according to uniform principles (Regulation, 2004), published by the European Statistical Office (Economic Accounts for Agriculture Values at Real Prices, 2018). On the basis of these sources of information, the real (in prices from 2010) level of LP in agriculture in the individual EU countries, measured by the relation of gross value added (GVA) to the number of annual work units (AWU), was estimated for 2005-2016. The level of LP estimated in the above manner was the basis for its multidimensional analyses

in the aspect of dynamics of changes, spatial differentiation and convergence/divergence processes.

The article analyses two basic types of convergence, i.e., sigma (δ) convergence and beta (β) absolute convergence. The former assesses the processes of convergence through the prism of changes in the degree of variation of the level of the studied phenomenon over time using different statistical measures of dispersion. The reduction in the variation of the studied phenomenon is generally the basis for a positive verification of the hypothesis about the occurrence of sigma (δ) convergence. However, it requires verification of statistical significance. This type of approach to verification of the occurrence of economic convergence, including in relation to the agricultural sector, is adopted by many researchers (see Baer-Nawrocka and Markiewicz, 2012; Baráth and Fertö, 2017; Ciołek, 2005; Galanopoulos, 2011; Ghosh, 2006; Gutierrez, 2000; Kumar et al. 2014; Kusideł, 2013; Rezitis, 2010; Sala-i-Martin, 1996 a, b; Suhariyanto and Thirtle, 2001; Quah, 1996). In turn, the essence of beta (β) convergence is to examine the relationship between the initial level of the examined feature and its dynamics of changes. If this relationship is negative, β convergence occurs, i.e., countries (regions) with a higher level of the analysed feature in the initial period develop more slowly than the countries where the level of this feature was lower. The relationship of this type is also verified in terms of statistical significance. This type of testing of economic convergence was formulated by Baumol (1986) and has been used in many empirical research of growth processes in agriculture and other sectors of the economy (Barro and Sala-i-Martin, 1992; Baumol, 1986; Ciołek, 2005; Cuerva, 2012; Galanopoulos, 2011; Ghosh, 2006; Gutierrez, 2000; Kumar et al., 2014; Kusideł, 2013; McErlean and Wu, 2003; Mankiw et al., 1992; Sala-i-Martin, 1996a, 1996b; Suhariyanto and Thirtle, 2001). The analysis of δ convergence of LP in the EU agriculture uses logarithmised standard deviation $sd(lnLP)$ and the coefficient of variation ($v[lnLP]$), calculated according to the following formulas:

$$sd(lnLP) = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (lnLP_i(t) - \overline{LP}(t))^2}$$

$$\text{and } v(lnLP) = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(lnLP_i(t) - \overline{LP}(t))^2}}{ln\overline{LP}(t)}$$

where: $\overline{LP}(t) = \frac{1}{n}\sum_{i=1}^{n} lnLP_i(t)$ - average level of LP in period t; $LP_i(t)$ - LP in the i-th country in the period t.

In addition, the δ convergence hypothesis was verified by estimating the equations of regression of standard deviation and the coefficient of variation of LP in the form of:

$sd(ln\ LP)=\alpha_0+\alpha_1 t+\varepsilon$ and $v(ln\ LP)=\alpha_0+\alpha_1 t+\varepsilon$

where: $sd(ln\ LP)$ - standard deviation of the natural logarithm of LP in agriculture between the EU countries in year t; $v(ln\ LP)$ - the coefficient of variation of the natural logarithm of LP in agriculture between the EU countries in year t; time variable (t = 1….12); ε – random disturbances.

In turn, one of the most commonly used models which explains the increase in the studied feature i = 1,….,N, between the period t_0 i t_0+T using the initial value of this feature was used to verify the beta-convergence hypothesis of LP in the EU agriculture, using cross-sectional data (Ciołek, 2005; Kusideł, 2013):

$$In\left(\frac{Y_{it_{0+T}}}{Y_{it_0}}\right) = \alpha_0 + \alpha_1 ln(Y_{it_0}) + \varepsilon_{it_0,t_0+T}$$

A negative or positive and statistically significant value of the estimator means the occurrence of convergence or divergence. If this parameter is not significant, the convergence or divergence parameter does not occur. The estimator α_1 of the above equation is also used to calculate the β parameter called the convergence coefficient. It is calculated from the transformation of the equation $\alpha_1=-(1-e^{\beta T})$ to the form $\beta=-ln(1+\alpha_1)/T$, where T is the time interval between extreme years of research (Kusideł, 2013, Tahir, 2012). Signs of β and α_1 parameters inform about the occurrence of convergence or divergence. If $\beta < 0$, there is divergence (discrepancy) between the studied units, whereas in the case of $\beta > 0$, there is convergence. On the basis of the size of the β convergence coefficient, it is possible to obtain information on what percentage of the distance from the so-called state of balance is covered in one period or how much in a given unit of time the difference between the actual value of the examined feature and its value in the stationary state of balance decreases (Kusideł, 2013. Generally, the higher the relative β value, the faster the rate of convergence/divergence. In addition, the β convergence coefficient is used to calculate the $HL_{1/2}$ (half-life), informing about the time needed to reduce current differences in the level of the studied phenomenon by half. In the case of the cross-sectional model presented above, this measure is calculated from the formula (Ciołek, 2005; Kusideł, 2013): $HL_{1/2} = \frac{ln2}{\beta}$.

In the analysis of convergence processes, very often there is the problem of the so-called atypical values which can have a very large impact on the estimation of parameters of convergence models, and thus on the assessment of its nature. Atypical values may cause a significant change in the value of assessment of structural parameters after their removal, but at the same time they do not have to generate large regression residues. *DfBeta* was used in the article to identify atypical values. The use of this measure, firstly, allows assessing the difference between the values of assessments obtained for regression at the full number of observations and for regression with the atypical value removed, and secondly, allows assessing the strength and direction of the impact of LP transformations in each of the EU countries on the convergence process by analysing changes in the β parameter. The size of this measure is calculated according to the formula (Belsley et al., 1980): $DfBeta = \frac{\hat{\beta}_j - \hat{\beta}_{j(i)}}{\sqrt{MSE_{(i)}(X^T X)^{-1}_{jj}}}$, where: $\hat{\beta}_j$ - means the j-th regression coefficient; $\hat{\beta}_{j(i)}$ - the same coefficient but without the i-th observation; $MSE_{(i)}$ - root mean square error.

3. CHANGES IN LP IN THE EU AGRICULTURAL SECTOR

Table 1 includes basic statistics presenting transformations in LP in the EU agriculture in 2005-2016 in terms of its level and dynamics of changes and in the aspect of dynamics of changes in GVA and employment in agriculture (AWU). Their analysis indicates that total LP in the EU in the analysed period increased on an annual average 2.13%, and this increase was the result of a much faster rate of decline in the number of people employed (−2.67%) than added value (−0.60%). The above path of changes in LP is essentially similar in the case of the EU-15 countries and the new Member States (EU-13). In the EU-15, transformations in LP were also determined by a downward trend in value added (−0.65%) associated with a relatively faster rate of decline in the number of people employed (−1.61%), which resulted in an increase in LP of 0.98% on annual average. In turn, in the EU-13, the favourable direction of LP changes (3.45%) was mainly determined by a strong reduction in employment (−3.64%), and to a much smaller extent by changes in value added (−0.32%). However, the intensity of these changes as well as their direction strongly differentiates the EU countries.

Taking into account the leaders in the growth of LP, attention should firstly be paid to dynamic changes in LP in agriculture of Poland, Hungary, the Czech Republic, Bulgaria and Slovakia. In Poland, its level increased on annual average by as much as 4.82% and resulted from the increase in value added (1.88%) and reduction in employment (−2.81%). Similarly, these changes took place in Hungary where a relatively high LP dynamics (4.75%) was associated with a strong increase in value added (3.01%) and a moderate reduction in the employment level (−1.66%). In turn, taking into consideration agriculture of the Czech Republic, it can be noted that the significant LP dynamics (5.25%) was to a similar degree determined by both increase in value added (2.54%) and a decline in the number of people employed (−2.57%). A strong reduction in employment is also the factor which predominantly determined high dynamics of increase in LP in agriculture in Bulgaria (5.77%) and Slovakia (6.6%). In these countries, with different changes in value added (2.46% and −0.04%) in terms of scale and direction, the number of people employed in agriculture on annual average decreased by 7.79% and 6.23%, respectively.

Clearly less favourable processes of changes in LP took place in agriculture of the majority of other new Member States, especially in Estonia, Croatia, Slovenia and Malta. In their case, there was a downward trend in the level of LP, generally (except for Malta) as a result of a faster rate of decrease in value added than employment. Among these countries, a very strong regression was recorded in Malta where LP dropped by as much as 3.56% on annual average,

Table 1: Labour productivity in the EU agriculture in 2005-2016 (EUR thousand/AWU, real values in 2010 prices)

EU countries	Labour productivity (EUR thousand/AWU)				ΔLP[1]	ΔGVA[2]	ΔAWU[3]
	2005-2007	2008-2010	2011-2013	2014-2016	%		
Austria	18,72	19,62	22,41	20,37	2,13	0,14	−1,95
Belgium	38,51	35,24	39,37	36,42	−0,03	−1,81	−1,77
Bulgaria	3,16	3,54	4,47	5,64	5,77	−2,46	−7,79
Croatia	6,57	7,20	5,87	4,87	−0,74	−3,14	−2,42
Cyprus	12,52	12,02	12,48	13,65	1,18	−1,71	−2,86
Czech Rep.	9,64	8,54	13,09	14,78	5,25	2,54	−2,57
Denmark	44,89	38,16	58,00	44,32	−1,19	−2,56	−1,38
Estonia	8,52	7,51	13,23	10,63	−1,78	−7,17	−5,49
Finland	15,39	15,67	15,54	13,82	−1,29	−3,98	−2,72
France	33,45	31,13	35,39	35,94	−0,14	−1,82	−1,69
Germany	25,82	29,86	37,92	32,85	2,75	0,95	−1,75
Greece	12,35	12,37	11,20	12,78	−1,07	−4,10	−3,06
Hungary	4,87	4,83	6,32	7,31	4,75	3,01	−1,66
Ireland	10,65	7,60	11,28	13,03	0,22	1,10	0,88
Italy	24,38	23,48	27,19	26,52	0,17	−0,76	−0,93
Latvia	2,98	2,57	2,96	3,88	3,17	−2,26	−5,26
Lithuania	4,53	4,51	6,70	6,28	2,91	1,48	−1,39
Luxemburg	31,50	27,02	25,89	28,44	−0,87	−2,17	−1,31
Malta	15,78	13,73	10,90	10,84	−3,56	−1,65	1,99
Netherlands	62,11	58,78	61,88	66,51	1,38	0,42	−0,94
Poland	3,32	3,63	4,74	4,43	4,82	1,88	−2,81
Portugal	8,18	7,97	7,89	9,54	1,32	−2,22	−3,49
Romania	3,14	3,59	4,50	4,25	1,02	−3,37	−4,35
Slovakia	6,64	5,73	9,89	10,91	6,60	−0,04	−6,23
Slovenia	5,69	4,95	5,18	5,85	−0,41	−1,48	−1,07
Spain	25,00	22,88	24,74	29,61	1,53	−0,12	−1,63
Sweden	21,21	21,13	24,35	26,45	3,34	0,93	−2,33
U. Kingdom	21,42	27,68	33,12	31,65	2,84	2,44	−0,39
UE-28	13,26	13,65	16,38	16,80	2,13	−0,60	−2,67
UE-15	24,38	24,09	27,53	28,04	0,98	−0,65	−1,61
UE-13	3,77	4,03	5,18	5,16	3,45	−0,32	−3,64

[1]ΔLP – the annual average dynamics of changes in labour productivity, [2]ΔGVA – the annual average dynamics of changes in GVA, [3]ΔAWU – the annual average dynamics of changes in employment in agriculture

i.e., the fastest in the EU, following a downward trend in value added (−1.65%) and an upward trend in employment in agriculture (1.99%). Taking into account the EU-15 countries, it can be noted that in half of them LP decreased (Denmark −1.19%, Greece −1.07%, Luxembourg −0.87%, Finland −1.29%) or changed to a marginal extent (Belgium −0.03%, Ireland 0.22%, France −0.14%, Italy 0.17%), while in others it had an upward trend (Germany 2.75%, Spain 1.53%, the Netherlands 1.38%, Austria 2.13%, Portugal 1.32%, Sweden 3.34%, the United Kingdom 2.84%). In the EU-15 countries, where a marked decline in LP was observed, unfavourable trends were determined by negative changes in value added which in the analysed period decreased on annual average in the range of 2.17-3.98%, with a decreasing, but more slowly, employment level (1.31-3.06%). On the other hand, the increase in LP in the countries of this group resulted mainly from the increase in the value added associated with the decline in employment. Only Portugal and Spain stepped out of this path of LP growth. In Portuguese agriculture, a quite strong downward trend in value added was recorded (−2.22%), however, weaker than the dynamics of decline in employment (−3.49%). The decline in the employment level (−1.63%) was also the factor that largely determined the increase in LP in Spanish agriculture. However, unlike in Portugal, the impact of changes in the value added of agriculture on changes in LP in Spain was small, GVA decreased on annual average to a small extent (−0.12%).

The significantly higher growth rate of LP observed in the analysed years in the EU-13 countries (3.45%) compared to the EU-15 (0.98%) did not translate into a significant reduction of differences in the level of LP between these groups of countries. Despite the fact that both groups of countries are not uniform in terms of LP, the differences between them are still very large. It can be noticed that on average in 2005-2007, LP in the EU-15 (EUR 24.38 thousand/AWU) was nearly seven times (6.5) higher than on average in the EU-13 (EUR 3.77 thousand/AWU), and in 2014-2016, this relation decreased to about five (5.4). These relations indicate that despite a clear progress in LP, its level in agriculture in the new Member States is still significantly lower. But then, the direction of changes in this relationship suggests that in the area of LP, convergence processes take place in the EU agriculture.

4. SIGMA (δ) CONVERGENCE/ DIVERGENCE OF LP IN THE EU AGRICULTURE

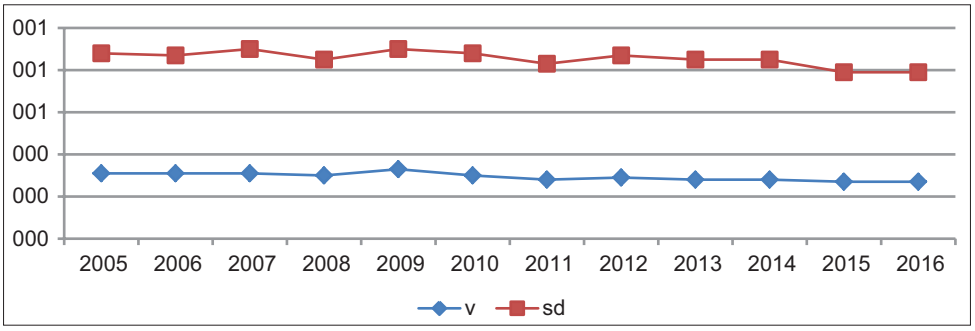
Table 2 and Figures 1 show changes in standard deviation (*sd*) and coefficient of variation (*v*) of LP values, for which logarithms were found, in the EU agriculture. The above measures of dispersion were used to verify the occurrence of sigma (*δ*) convergence/ divergence. The analysis of data included in Table 2 indicates that the convergence measures used have decreased in the analysed period which indicates a gradual levelling of differences in the level of LP in agriculture between the EU-28 countries. Taking into account the coefficient of variation (EU-28), it can be noticed that in the analysed years its level was substantially decreasing, and this trend was subject to minor disturbances only in 2 years, i.e., in 2009 and 2012, in which – compared to previous years – there was a not very strong but noticeable increase in the level of this measure (33.4% and 29.1%). However, these deviations from the general trend did not disturb the main direction of changes. Its determinants are the levels of volatility index which in 2005-2007 (31.0-31.2%) were higher than in 2014-2016 (27.0-28.7%). The direction of changes in the size of this dispersion measure suggests the occurrence of processes of sigma (*δ*) convergence of LP.

Quite similar conclusions result from the assessment of convergence of LP by means of standard deviation. In the analysed years, the size of this measure of polarisation decreased in the EU-28, and slight deviations from the trend are noticeable only in 2007, 2009 and 2012. However, also these deviations from the general trend did not disturb its direction of changes. In 2005-2007, the level of standard deviation (0.87-0.90) of LP in the EU-28 was higher than in 2014-2016 (0.79-0.85).

Table 2: Sigma (*δ*) convergence of labour productivity in the EU agriculture in 2005-2016 measured by standard deviation (*sd*) and coefficient of variation (*v*)

Measure	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
v	0,31	0,31	0,31	0,30	0,33	0,30	0,28	0,29	0,28	0,28	0,27	0,27
sd	0,88	0,87	0,90	0,85	0,90	0,88	0,83	0,87	0,85	0,85	0,79	0,79

Figure 1: Sigma (*δ*) convergence of labour productivity in the EU agriculture in 2005-2016 measured by standard deviation (*sd*) and coefficient of variation (*v*)



Trends in sigma (δ) convergence of LP presented above generally suggest the occurrence of convergence processes of LP in EU agriculture. In order to verify this hypothesis, regression models were developed, whose parameters form the basis for the statistical assessment of the significance of the studied phenomenon, and thus a clear evaluation of its nature. Table 3 presents parameters of the linear regression function of the trend of changes in applied dispersion measures for the EU. On their basis, it can be concluded that the negative signs of time variables α1 and their high levels of significance ($p(\alpha_1) = 0.000$) indicate clearly, both in the case of the coefficient of variation ($\alpha_1 = -0.420$) and standard deviation ($\alpha_1 = -0.007$), the processes of sigma convergence of LP in the EU. The parameters of this model are quite well aligned with empirical data. The time variable explains the variability of dispersion measures of LP in the EU in 63.6% and 52.8%.

5. BETA (β) CONVERGENCE OF LP IN THE EU AGRICULTURE

Beta convergence is a condition necessary, but not sufficient for sigma convergence to occur. It is possible that regions with a low level of the studied phenomenon will develop faster than regions with higher level. However, this does not necessarily mean a reduction in the distance between them (Quah, 1996, Sala-i-Martin, 1996a). Sigma convergence is a sufficient but unnecessary condition for beta convergence to occur, and as a consequence the absence of sigma convergence does not allow concluding that regions with a lower initial level of the studied phenomenon do not develop faster than others. As already pointed out, beta convergence occurs when regions with an initially lower value of the studied feature show a faster growth rate than the regions with initially higher value. A tool used to verify this type of relationship is usually their graphical presentation and econometric models where the dependent variable is assumed to be the periodic growth dynamics of the studied feature, and the explanatory variable – its value from the beginning of the analysed period. Figure 2 and Table 4 include basic information which is the basis for assessing the nature of β convergence/divergence processes related to LP in agriculture in the EU-28.

Table 3: Parameters of sigma (δ) convergence regression models of labour productivity in the EU agriculture (2005-2016)

Measure	α_0	α_1	$t(\alpha_0)$	$t(\alpha_1)$	$P(\alpha_0)$	$P(\alpha_1)$	R^2
v (%)	32,45	−0,420	47,29	−6,20	0,000	0,000	0,636
sd	0,889	−0,007	56,94	−3,52	0,000	0,000	0,528

Taking into account all the EU countries, it can be noted (Figure 2) that the slope of the line reflecting the relation between the annual average LP growth rate and its initial level is negative, which suggests the occurrence of beta convergence. In addition, the vast majority of countries are located along and close to the regression line, and greater deviations in this respect are noticeable in relation to the countries forming two aggregations. The first one is made up of Germany, the United Kingdom and Sweden, while the second of Malta, Ireland, Greece and Finland. In case of the first group of countries, their rather remote location over the regression line denies the hypothesis of beta convergence. The level of LP in agriculture in Germany, United Kingdom and Sweden was relatively high in the initial period compared to the average level in the EU-28, and in the analysed period it was increasing also with a relatively high dynamics. Thus, the path of transformations of LP in agriculture in these countries inhibits beta convergence processes. Taking into account the second group of countries, it is not hard to see that Malta, Ireland, Greece and Finland are located quite far below the regression line, in a place indicating the level of LP generally similar to the average in the EU-28 but related to the negative direction of its changes. This

Table 4: Regression model of absolute type β convergence of labour productivity in EU agriculture

Regression parameters							β (%)	$HL_{1/2}$
α_0	α_1	$t(\alpha_0)$	$t(\alpha_1)$	$P(\alpha_0)$	$P(\alpha_1)$	R^2		
0,2218	-0,0576	5,9010	-4,2910	0,0000	0,0000	0,0407	+0,49	140

Marking of model parameters: α_0 – constant of equation, α_1 – value of the parameter with explanatory variable $\ln(Yit_0)$, t – student's t-statistics, P – significance levels, R^2 – coefficient of determination, β – annual convergence rate (%), $HL_{1/2}$ (half-life) – time to reduce half of the productivity gap (in years)

Figure 2: Beta (β) convergence of labour productivity in EU agriculture (2005-2016)

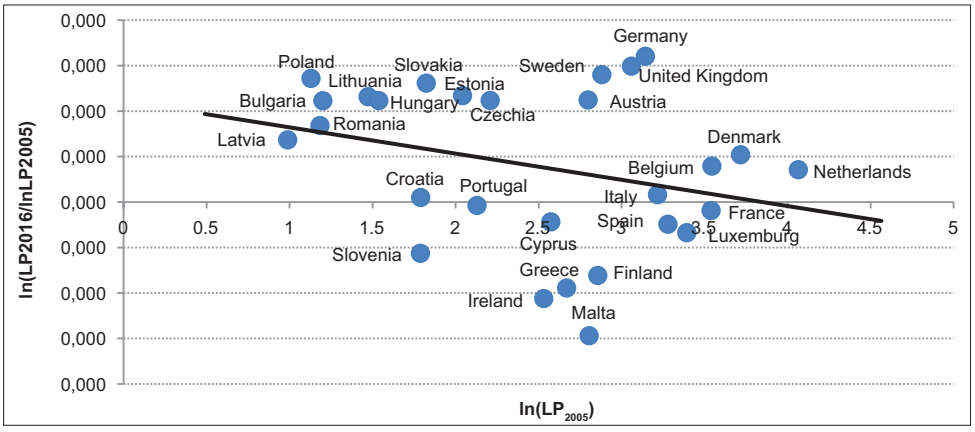


Table 5: The impact of the individual EU-28 countries on the value of labour productivity convergence parameters (α_1, β, $HL_{1/2}$) measured by *Df*Beta

EU countries	*Df*Beta	Direction of impact +/−	α_1 parameter	β (%)	$HL_{1/2}$ (years)
Total EU			-0,058	0,49	140
Poland	−0,473	+	−0,049	0,42	165
Malta	−0,353	+	−0,052	0,44	156
Lithuania	−0,289	+	−0,053	0,45	154
Slovakia	−0,287	+	−0,053	0,45	153
Bulgaria	−0,273	+	−0,053	0,45	153
Luxemburg	−0,261	+	−0,053	0,46	152
Hungary	−0,257	+	−0,053	0,46	152
Finland	−0,252	+	−0,054	0,46	151
Spain	−0,200	+	−0,054	0,47	149
Estonia	−0,172	+	−0,055	0,47	148
Greece	−0,149	+	−0,055	0,47	147
France	−0,119	+	−0,056	0,48	145
Czech Republic	−0,105	+	−0,056	0,48	145
Romania	−0,056	+	−0,057	0,49	143
Ireland	−0,048	+	−0,057	0,49	142
Italy	−0,046	+	−0,057	0,49	142
Cyprus	−0,034	+	−0,057	0,49	142
Portugal	0,113	−	−0,060	0,51	136
Latvia	0,130	−	−0,060	0,52	134
Austria	0,159	−	−0,060	0,52	134
Belgium	0,199	−	−0,061	0,53	132
Croatia	0,228	−	−0,062	0,53	131
Sweden	0,275	−	−0,062	0,54	130
Denmark	0,365	−	−0,064	0,55	126
Netherlands	0,405	−	−0,065	0,56	123
U. Kingdom	0,448	−	−0,065	0,56	123
Slovenia	0,486	−	−0,066	0,57	122
Germany	0,567	−	−0,067	0,58	120

type of relations between the initial level of LP and its dynamics of changes is conductive to β convergence.

In order to verify the hypothesis of β convergence of LP in the EU-28, a cross-section growth regression was estimated in which explanatory variables are growth rates of LP in agriculture, in accordance with the formula described in the methodical part of the article. In addition, the strength of the influence of individual countries on the value of the β convergence parameter was estimated using *DfBeta*. The assessment of α1 parameter for the EU-28 presented in Table 4 is negative ($\alpha_1 = -0.0576$), which means that the processes of LP convergence were taking place in the EU in the analysed period. In addition, the convergence parameter is statistically significant ($p(\alpha_1) = 0.000$) but explains the grow rate of LP only in 3.8-4.1%. Thus, the estimated parameters of the model, on the one hand, indicate the process of convergence of LP in the EU agriculture and, on the other, also inform about its very weak dynamics. Between 2005 and 2016, the annual rate of β convergence of LP was only 0.49%, which means that the time of reduction of half of the LP gap is as much as around 140 years. This assessment also does not change fundamentally by omitting Germany, the United Kingdom and Sweden in the modelling. Even though, in the light of data in Table 5, the negative impact of the nature of changes in LP in agriculture in these countries on the process of convergence in the EU is relatively high (*DfBeta* = 0.448-0.567), their omission has a limited impact on both the acceleration of the convergence rate (β = 0.56-0.58) and the time of reduction of half of the LP gap ($HL_{1/2}$ = 120-123 years). It is also worth emphasising that changes in the convergence of LP in Poland had the strongest and positive influence on it in the EU-28 (*DfBeta* = −0.473). Although the omission of Poland in the construction of the productivity growth model does not translate into a significant slowdown in the convergence rate (β = 0.42), it results in a fairly marked extension of the time of reduction of the productivity gap to 165 years.

6. CONCLUSION

The conducted analyses confirmed the occurrence of sigma and beta convergence processes of LP in agriculture of the European Union. However, these processes have very weak dynamics as evidenced by both the low rate of decrease in the level of LP dispersion measures and the low rate of its convergence in the EU-28 of only 0.49% per year, which translates into a remote half time of reduction of the LP gap amounting to 140 years.

To sum up, one of the most important general objectives of the European integration, which is to reduce the differences in the level of development between countries and regions, is implemented in the case of agricultural LP to a small extent. The dispersion of the LP level is still very high, and the rate of its levelling very slow. It should be assumed that without significant acceleration of broadly understood structural changes in agriculture, LP convergence processes will not accelerate, and the lack of clear progress in this respect will determine the marginal scale of changes in the level of agricultural development between the EU countries in the long term.

REFERENCES

Baer-Nawrocka, A., Markiewicz, N. (2012), Processes of convergence/divergence of labour productivity in agriculture of the European Union regional analysis. Journal of Agribusiness and Rural Development, 3(25), 13-23.

Baráth, L., Fertö, L. (2017), Productivity and convergence in European agriculture. Journal of Agricultural Economics, 68(1), 228-248.

Barro, R.J., Sala-i-Martin, X. (1992), Convergence. Journal of Political Economy, 100, 223-251.

Baumol, W.J. (1986), Productivity growth, convergence and welfare: What the long-run data show. American Economic Review, 76, 1072-1085.

Belsley, D.A., Kuh, E., Welsch, R.E. (1980), Regression Diagnostics: Identifying Influential Data and Sources of Collinearity. New York: Wiley.

Ciołek, D. (2005), Convergence of Countries in Transition to EU Countries. University of Gdańsk, Doctoral Dissertation. Available from: https://www.researchgate.net/publication/311653877.

Cuerva, M.C. (2012), Determinants of labour productivity convergence in the European agricultural sector. Agrociencia, 46(6), 621-635.

Economic Accounts for Agriculture Values at Real Prices. (2018), Available from: http://www.appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aact_eaa04&lang=en.

Galanopoulos, K. (2011), Agricultural productivity growth in the Euro-Med region: Is there evidence of convergence? Outlook on Agriculture, 40(1), 29-37.

Ghosh, M. (2006), Regional convergence in Indian agriculture. Indian Journal of Agricultural Economics, 61(4), 610-629.

Gutierrez, L. (2000), Convergence in US and EU agriculture. European Review of Agricultural Economics, 27(2), 187-206.

Kumar, S., Lala, K.A., Chaudhary, K.R. (2014), Agricultural growth and economic convergence in Indian agriculture. Indian Journal of Agricultural Economics, 69(2), 211-228.

Kusideł, E. (2013), Economic Convergence in Poland and its Importance in Achieving the Objectives of Cohesion Policy. Poland: Publisher of the University of Lodz.

Mankiw, N.G., Romer, D., Weil, D.N. (1992), A contribution to the empirics of economic growth. Quarterly Journal of Economics, 107, 407-437.

McErlean, S., Wu, Z. (2003), Regional agricultural labour productivity convergence in China. Food Policy, 28(3), 237-252.

Quah, D.T. (1996), Empirics for Economic Growth and Convergence. European Economic Review, 40, 1353-1375.

Regulation (EC) No 138/2004 of the European Parliament and of the Council of 5 December 2003 on the Economic Accounts for Agriculture in the Community (Text with EEA relevance). Available from: https://www.eur-lex.europa.eu/legal-content/PL/TXT/?uri=CELEX:32004R0138.

Rezitis, A.N. (2010), Agricultural Productivity and convergence. Europe and the United States. Applied Economics, 42(8), 1029-1044.

Sala-i-Martin, X. (1996a), Regional cohesion: Evidence and theories of regional growth and convergence. European Economic Review, 40, 1325-1352.

Sala-i-Martin, X. (1996b), The classical approach to convergence analysis. The Economic Journal, 106, 1019-1036.

Suhariyanto, K., Thirtle, C. (2001), Asian agricultural productivity and convergence. Journal of Agricultural Economics, 52(3), 96-110.

Tahir, M. (2012), Labour productivity convergence in 52 industries: A panel data analysis of some European countries. International Journal of Economics and Financial Issues, 2(3), 320-339.